

The Density Contrast of the Shapley Supercluster

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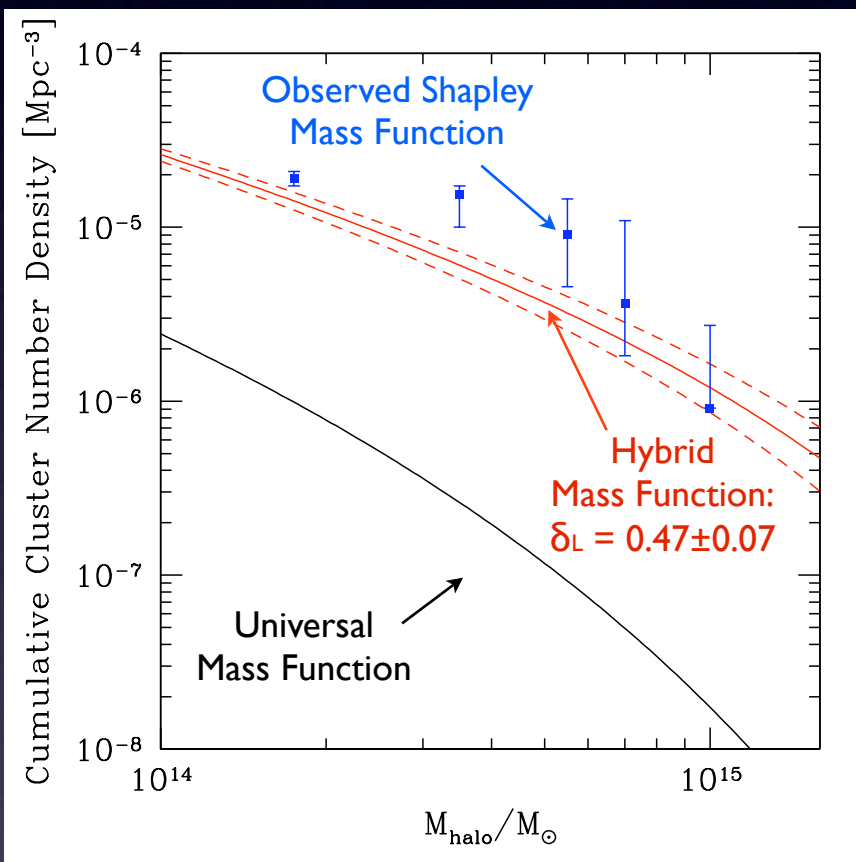
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We calculate the density contrast of the Shapley Supercluster (SSC) based on the enhanced abundance of X-ray clusters in it, using the extended Press-Schechter formalism. We derive a total SSC mass of $M_{\text{tot}} = (4.4 \pm 0.44) \times 10^{16} M_{\odot}$ within a sphere of 50 Mpc centered at a distance of about 160 Mpc. The nonlinear fractional density contrast of the sphere is $(1+\delta) = 1.76 \pm 0.17$ relative to the mean matter density in the Universe, but the contrast increases in the interior of the SSC. Including the cosmological constant, the SSC region is found to be gravitationally unbound. The SSC contributes only a minor portion ($9.0\% \pm 2.1\%$) of the peculiar velocity of the local group.

Method

ePS+ST=Hybrid:
(Barkana & Loeb 2004)

- Collapsed objects are more abundant in overdense regions than in regions of mean density.
- We can fit the hybrid mass function to number of observed halos.
- Linear overdensity is a free parameter.



Sample:

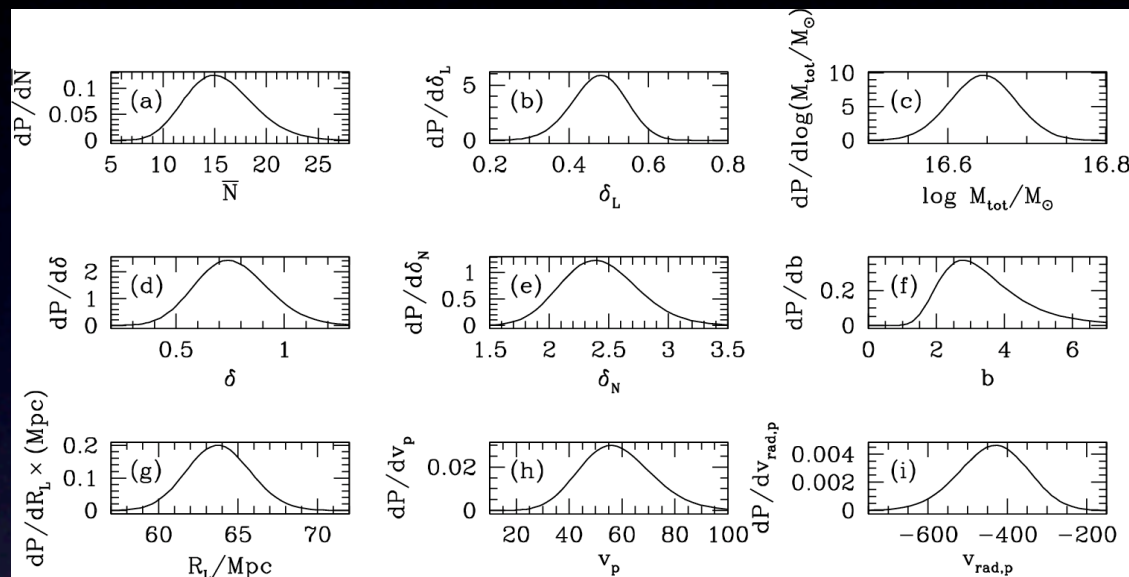
- 21 clusters from de Filippis et al. (2005, 20) and Ebeling et al. (2002, 1)
- $T_X \rightarrow M_{\text{halo}}$ (Vikhlinin et al. 2008)
- $M_{\text{halo}} > 1.75 \times 10^{14} M_{\odot}$
- Center at A3558; distance ≈ 160 Mpc
- 51 Mpc in extent
- Assume each cluster is associated with exactly one halo (not part of substructure)

References:

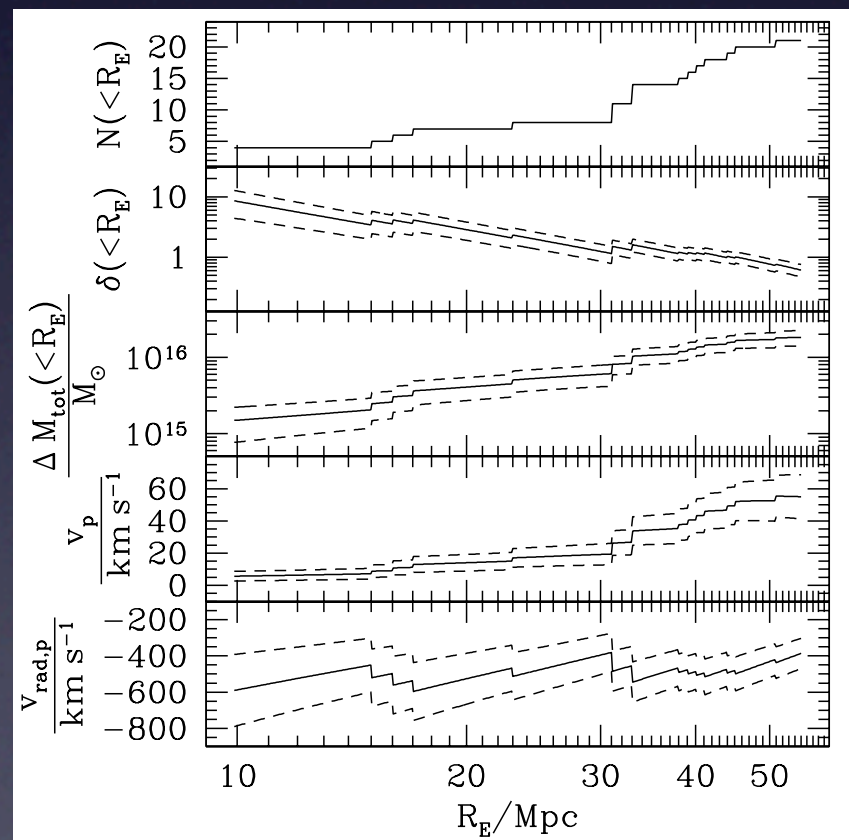
Barkana R., Loeb A., 2004, *ApJ*, 609, 474
de Filippis E., Cole S., Efstathiou G., Kaiser N., 1991, *ApJ*, 379, 440
Ebeling H., Mullis C. R., Tully R. B., 2002, *ApJ*, 580, 774
Vikhlinin et al., 2008, in preparation

Results

Probability Distributions of Parameters:



Radial Profile:



- N : Observed number of clusters
- \bar{N} : Expected number of clusters
- δ_L : Linear matter overdensity
- M_{tot} : Total Shapley mass
- ΔM_{tot} : Excess mass above mean
- δ : Nonlinear matter overdensity
- δ_N : Cluster overdensity
- b : Cluster bias
- R_L : Lagrangian radius
- v_p : Contribution to peculiar velocity of the local group (in km/s)
- $v_{\text{rad,p}}$: Peculiar radial velocity of 51 Mpc shell (in km/s)

Conclusions

- $\delta_L = 0.47 \pm 0.04$; $\delta = 0.76 \pm 0.17$
- $M_{\text{tot}} = (4.4 \pm 0.44) \times 10^{16} M_{\odot}$
- Shapley makes only a minor contribution to the peculiar velocity of the local group.
- 50 Mpc region is unbound.